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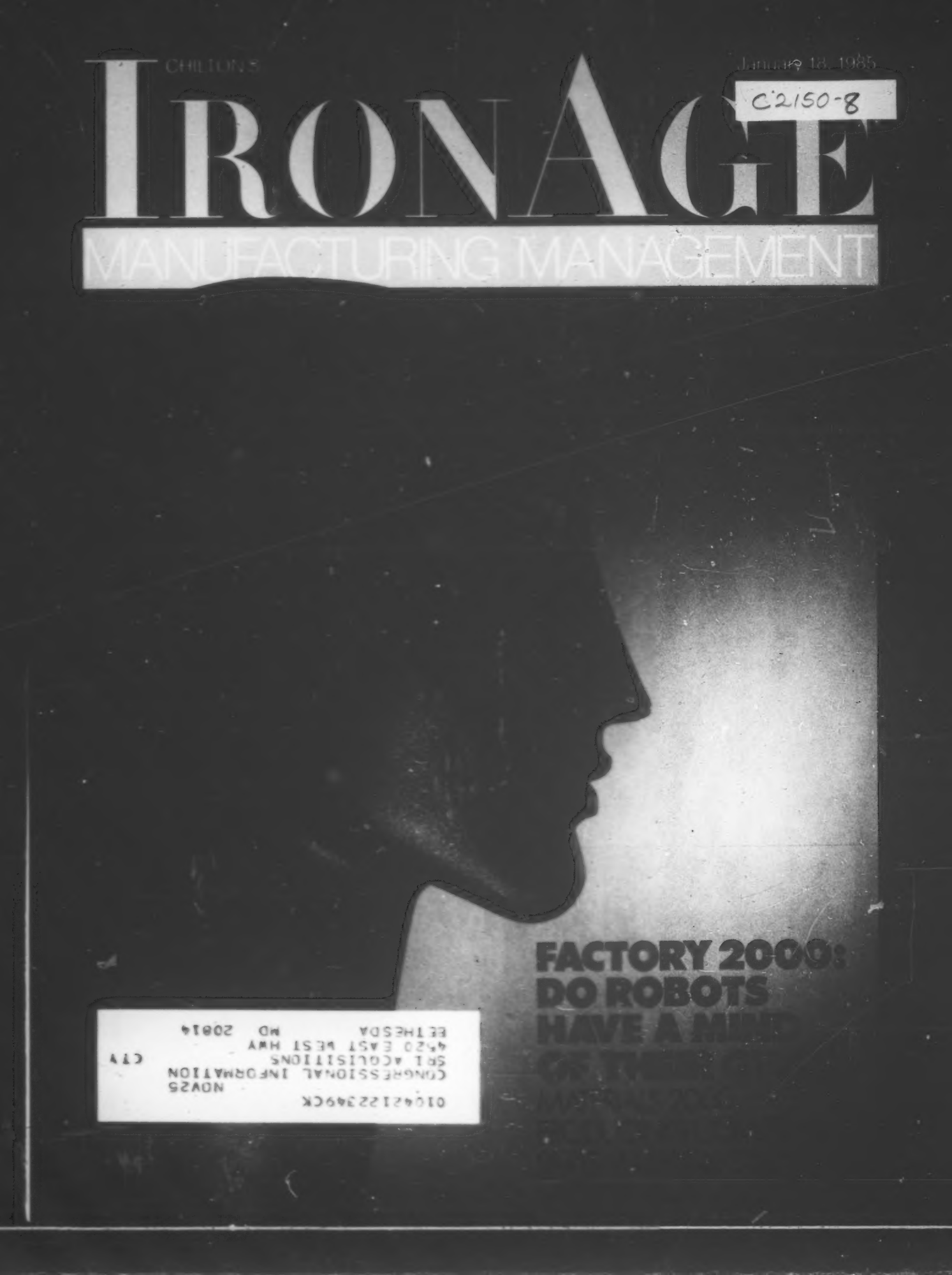

FACTORY 2000: DO ROBOTS HAVE A MIND OF THEIR OWN?

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IRON AGE
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In fact, the Japanese government pledged to help raise 25 pct of the construction costs.

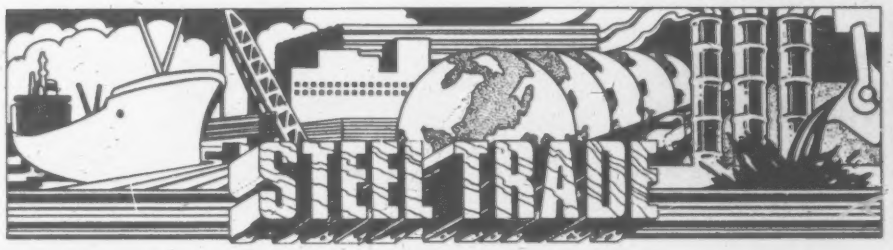
California also supported the plan, at least when it was first announced. In 1982 the state legislature authorized the sale of $1.25 billion in state revenue bonds to help raise money for the bullet train. It was also exempted from many state environmental regulations.

Bullet train proponents claimed once the project was operational, it would be self-supporting. But opponents, which included many state newspapers, politicians, and environmentalists, claimed the project would ultimately cost much more than originally estimated and would never be able to attract an adequate amount of riders.

The system has to be all-electric, using an overhead catenary system. The 131 mile system was planned to maintain 100 trains per day operating at a top speed of 160 mph. It was to take 59 minutes to make the run.

Fluor Corp. of Irvine, Calif. had been selected to build the system and to serve as construction and engineering project manager.

American High Speed Rail officials told reporters that Amtrak would purchase the engineering and marketing data compiled on the proposed route, and that AHSRC would cease operating when the last of the $10 million with which the company had been funded was spent. Most of the money had come from Japanese and American companies that had a stake in the ill-fated project.



Administration obtains steel trade accords with 7 nations

Voluntary trade agreements were negotiated by the U.S. with nations which accounted for 53 pct of American steel imports in 1984.

The seven nations in question were Australia, Brazil, Japan, Mexico, South Africa, Korea and Spain. Already in place was the 1982 European Common Market agreement which covered 22 pct of last year's imports.

Domestic producers praised the Reagan Administration for its progress in limiting steel imports through voluntary agreements. Announced Sept. 18, the Reagan program called for holding imports of finished steel to 18.5 pct of U.S. supply. Imports of semifinished steel would be no more than 1.7 million tons.

Government officials had carried out the trade negotiations "with great skill and dedication," said Donald H. Trautlein, chairman of Bethlehem Steel Corp. and of the American Iron & Steel Institute (AISI).

"The process of implementing the President's program is just beginning," Mr. Trautlein added, "and will require considerable further action."

As of late 1984, no agreements had been reached with countries that accounted for 25 pct last year's imports. Canada accounted for 12 pct of the total. The combined tonnage of Sweden, Venezuela, Finland and Argentina came to 7 pct.

When the seven agreements were announced Dec. 19, U.S. producers promptly took action against countries still outside the program.

United States Steel Corp. filed dumping and subsidy suits against Venezuela, Austria, Sweden, and five Communist countries: Czechoslovakia, East Germany, Hungary, Poland and Romania. The suits dealt mostly with sheet products.

Chaparral Steel Co. filed complaints against Norwegian and Polish suppliers of structural steel. Bethlehem Steel sought curbs on sheet from Finland.

U.S. Steel said its trade actions were "complementary" to the government's negotiations. It wasn't clear if the suits were aimed at providing leverage for negotiations or were seen as the only means of dealing with some countries.

The Canadian situation was hazy at yearend. Canada's major steel producers have never been charged with dumping or illegal subsidies. The Canadians have argued that they shouldn't be included in a program that is supposedly directed only at unfair trade.

(Cont. on p. 18)

1984 Imports - Nine Months

Country	Tonnage	Pct Share of Imports	Proposed Pct of U.S. Supply
EEC	4.438	22	5.4
Voluntary Agreements			
Japan	5.060	26	5.8
Korea	1.835		1.9
Spain	1.236		0.67
Brazil	1.044	27	0.8
South Africa	0.493		0.42
Australia	0.170		0.18
Mexico	0.707		0.36
No Agreements			
Canada	2.402	12	(3)
Venezuela	0.376		
Argentina	0.238	7	
Sweden	0.501		
Finland	0.267		
Others	1.188	6	

DO ROBOTS HAVE A MIND OF THEIR OWN?

Manufacturers are beginning to use robots with sensing and intelligence that can adapt to changing factory conditions.

BY ROBERT E. HARVEY

Robots, sophisticated enough to sense objects, intelligent enough to interpret those sensings, and adaptable enough stay on top of changing factory conditions, are the wave of the near future.

"I am not making a prediction but I would think that by 1990, the vast majority of robots will have adaptive capabilities, perhaps all of them." explained Dick Beecher, manager of robotics, advanced product and manufacturing engineering staff, General Motors Corp.

Most advanced robotic systems today remain laboratory curiosities—however, not all. The recent installation of some intelligent systems signals a major step forward in automation development.

General Motors, already using robots for body shop tasks like spot welding, is now sending robots into trim and chassis operations.

"In those areas GM does not want to invest heavily in the fixed tooling needed to accurately position the auto bodies. Nor does GM want to fixture each body at each location," said Richard E. Hohn, product manager, Industrial Robot Division, Cincinnati Milacron Co., Lebanon, Ohio. "So they are looking at what could be called flexible fixturing."

Flexible fixturing lets robots adjust to inaccurately placed parts.

"The auto body is moved into position but that position can be off plus or minus an inch or two," said Mr. Hohn. "Next, the 3-D vision system, looking at three gage holes in the body, determines its precise location. The data is transferred to

Robot Sales by U.S. Robot Manufacturers

*1981 — $115 million
*1982 — $150 million
**1983 — $195 million
**1984 — $300 million
**1990 — $2 billion

*IA Estimate
**Robotic Industries Assn.

Grasping an aluminum aircraft section, an experimental robot at Lockheed-California Co., operates with the aid of a video camera.

Robot Technology Trends

Materials: Lighter and stronger materials for robot structures will be developed. These will include both organic and non-organic substances. As a consequence, the size and weight of robots will decrease.

Power Sources: Small, high-capacity power sources such as nuclear powered generators or fuel cells will allow robots greater freedom of location and movement.

Actuators: Small, high performance actuators will appear. Robot designs will be more stylish.

Sensors: Small, reliable, high-performance, low-cost artificial eyes, ears, and tactile sensors will be developed and even low-cost robots will have recognition capability.

Control Systems: Advances in microcomputer technology will dramatically improve robot control. Control system costs will also be greatly reduced.

Communications Systems: Remote control of industrial robots will be enhanced through development in fiber optics, wireless communications, etc.

Processing Methods: New, non-mechanical processing methods such as laser beam cutting, welding and other high-energy processing methods will reduce the processing load on robots and make the design work for them simpler.

Robot Body Structure: Utilization of biomechanical concepts will result in superior robot structures.

Software: Robot use will become easier through the development of robot languages, self-diagnosing systems and robot application technologies. Software will contribute to reducing the design work needed on robots.

Integrated Systems: Techniques for integrating production systems composed of men, machines and robots as well as their peripheral devices will be found. Further, their design processes will be computerized.

Source: *Overview of Artificial Intelligence and Robotics Vol. 2*, National Bureau of Standards.

the robot which uses the information to offset its original program and adjust its actions accordingly.

"We have some systems being installed that use this approach. In one case a body is precisely located so that sealant can be applied by the robot. In another, the vision system calculates the position of a windshield opening so a robot can correctly insert the windshield."

With vision structuring the environment for the robot, less expense goes toward the equipment that delivers and fixtures the parts that the robot works on.

In another application, GM has for the past year been using robots with vision to install door trim. Parts arriving on pallets are loosely positioned before a robot. The robot's task is to insert four different fasteners.

A 2-D vision system shows the robot where the fasteners should go and how much the robot should offset its program.

In the past, if a robot was programmed to insert a screw, for example, into a part, it would do its job oblivious to its environment. Now with tactile sensing and vision, it can adopt to unexpected changes such a missing screw or misalignment of parts.

Adaptable Robots

This new technology provides manufacturers with a choice between non-adaptable and adaptable manufacturing systems.

"It becomes a matter of an economic tradeoff," explained Mr. Beecher of GM. "One of the problems with robots in the past is that they have to operate within a structured environment. If you don't have some kind of structure, then you need some type of adaptive control. Is it less costly to structure the environment or is it less costly to apply some sort of sensory capability to allow the robots to adjust to the less structured environment?"

The aerospace industry, while as different as night from day in its manufacturing methods from the automotive industry, also is looking for intelligent robots that can adapt to less structured environments. The industry wants ease its dependence on hard inflexible tooling.

"Unlike the auto industry we build large complex items very slowly," explained Wallace J. Plumley, group engineer, Robotics and Automation Group, Manufacturing Research Division, Lockheed-Georgia Co., Marietta, Ga. "We are building our high-volume plane, the C-130, at a rate of two and-a-half to three a month. We have thousands of parts which go into each shift, but we do not have enough parts of any one kind flowing through to have a continuous flow. With a flexible robot, however, we can run families of parts through manufacturing cells. But we need to eliminate our hard tooling, which is expensive to make and to maintain."

The aerospace industry needs smarter robots because, while automation is needed to insure quality and precision, short product runs make hard tooling prohibitively expensive to use.

Another reason for intelligent robots: "We have been building C-130 aircraft since the late 1950s," said Mr. Plumley. "We have changed models several times. But since the Air Force would not enjoy scrapping an airplane because we scrapped the tooling for that particular model in 1962, we have to store large amounts of tooling. However, tool storage would be no problem if tooling was simply magnetic impulses on tape, which could be fed into a robot or a flexible manufacturing system."

Lower Tooling Costs

Although very few are currently in operation, advanced robotic sys-

tems are recognized by many as a necessary response to the dizzying variety of parts and part changes that go into aircraft production.

Lockheed-California Co., for example, has developed an experimental intelligent robot riveting system. As parts to be riveted are retrieved from storage trays, an overhead camera identifies them, using geometric data from a data base.

With this information, the robot can recognize and verify the part before it positions it on the riveting machine. One camera helps align the part, while other cameras verify the rivet's location and inspect the work while it is progressing.

The robot picks up parts with a flexible multi-fingered pneumatic gripper and can handle many part configurations without requiring templates and specific tooling.

As evidenced by what is being done by General Motors and others, the technological obstacles that have stood in the way of advanced robotic development are being overcome. The systems expertise and hardware (the robot arms, sensing systems and controls) needed to cost-effectively implement intelligent robotic manufacturing systems are available now, say robot users.

"We believe that current unmanned machining systems are reliable enough to run without anomalies for extended periods of time," said Robert L. McMahon, Jr., manager of factory systems, General Dynamics Corp. "In fact we have decided to put in a flexible manufacturing system."

With hardware now developed to the point where it is now adequate for advanced robotic systems, the development of software to coordinate this hardware will command the lion's share of attention for the next few years. Much work must still be done on coordinating the machines within a robot cell as well as getting robot and machine tool controllers to work well with supervisory computers.

Software Needed

"One of our activities involves developing manufacturing cells, and the bulk of the development required there is certainly in the development of the software," said Mr. Beecher of GM. "For example, we have a system in our labs that uses similar robots, so they all talk the same language and they all talk with the same controller. But there is still miles of software required to interface all this and to get that cell to do all the things we want it to do."

The high development costs of specialized software is an expense that will remain high, although many believe that standard software and communications standards such as the Manufacturing Automation Protocol (MAP) will lead to lower costs. MAP is a set of communications standards for off-the-shelf hardware and software being developed under GM's guidance which will allow manufacturing equipment to communicate with each other.

Mr. Beecher of GM, however, doesn't believe that MAP, while very beneficial, will reduce the cost of software for robots. "Software has been that black box, that proprietary edge, that one manufacturer might have over another. As long as GM (MAP) can enable these systems to talk to each other, regardless of what language they might speak individually, we can do a good job."

However, robots aside, MAP should make software packages more marketable, remarked another GM official.

"The technology (for advanced robotic systems) is certainly here," suggested Christopher Lea, manager of marketing applications for vision products, Automation Intelligence Inc., Orlando, Fla. "With advancing microprocessor technology leading the way, the cost of the hardware is coming down and that trend is going to continue.

"The software costs for custom packages are very expensive and the way to get around that is with standard packages. However, at this time, nothing plays together readily and easily, making the costs for these systems relatively high."

Lester V. Ottinger, president, RSI (Robot Systems Inc.), Norcross, Ga., believes that MAP will reduce some costs. "Prices should come down. When you have a standard and everyone is building to the standard, redesign and debugging is minimized. However, the price reductions will probably not be primarily in software but in peripherals and communication links."

"The biggest cost is certainly in software but not computer software," said Mr. McMahon of General Dynamics. "It is really in application development, trying to understand everything that goes on in a particular operation, all the tasks that people perform."

Mr. McMahon believes, however, that with computers growing more

(Cont. on p. 34)

Desirable Goals for Future Robots

- Rudimentary sense of vision to provide
  - Recognition data
  - Orientation data
- Tactile sensing to provide
  - Recognition data
  - Orientation data
  - Physical interaction data
- Computer interpretation of the visual and tactile data
- Multiple appendage hand-to-hand coordination
- Computer directed appendage trajectories
- Mobility
- Minimized spatial intrusion
- Energy conserving musculature
- General purpose hands
- Man-robot voice communication
- Total self diagnostic fault tracing
- Inherent safety (Asimov's Laws of Robotics)
- All the capabilities above available for a price which allows purchase and operation within the traditionally accepted rules for economic justification of any new equipment.

Source: J. F. Engelberger, *Robots in Practice*, American Management

powerful, expensive efficient software will not be needed. "You will be able to buy standard inefficient software and customize it to your particular application. It will not be very efficient, but with computer power becoming so cheap, who cares."

If software is becoming the overriding concern, continued advances in hardware are also needed if sophisticated robotic systems are to catch on in a big way.

Hardware Needed

"Just because the hardware for advanced robotic systems is available does not mean that we are completely satisfied with it, we certainly are not," remarked Mr. Beecher of GM. "For example, industrial robots are not fast enough, they are not as accurate as we would like them to be. They are not as repeatable, not as energy efficient, and they don't have the weight carrying capacity we would like."

In addition, Mr. Beecher is still looking for robots that travel from place to place. "We expect to see in the relatively near future robots with mobility. Not just the ability to move laterally on a track but actually move around a plant.

"We also are hampered because of the inflexibility of end effectors or grippers. Every time we want to handle something different we have to design a new gripper to handle the bloody thing. In addition, we need what we call smart end effectors or grippers."

These smart grippers would be able to do things like sense torque in a screw driver as well as know if the screw to be turned actually exists.

"Another thing we have a problem with is having to shut down a manufacturing line in order to reprogram the robots. Off-line programming is a big need," said Mr. Beecher. GM is working with several off-line programming systems (including one they have developed on their own), but so far none have been applied on a large scale.

"Another problem we have been trying to master for years is the black art of parts feeding and orientation," said Mr. Beecher. "We need parts feeders that are more universal and programmable. It is still difficult to crowd material around robots in such a way that the robots can actually get at them."

The solution to the material handling problem will probably be a combination of improved material handling and vision systems

GM is looking at using one robot to feed another robot. "The best universal parts feeder we can find, apart from the human, is another robot. So we are considering the possibility of robots presenting parts to other robots: material handling robots supplying manufacturing robots, for example, continued Mr. Beecher."

Wishing to expand its use of robots, the aerospace industry also is interested in seeing some hardware improvements.

"We could certainly use a hand that is capable of picking up a part regardless of orientation," reported Mr. Plumley of Lockheed-Georgia, "We could certainly use a vision/computer/robot combination that could pick detailed parts out of a plastic tote pan and properly orient them in an assembly fixture. We could certainly use robots, either very large or track mounted, that could sink rivets from both sides of a 10 ft by 30 ft fuselage section. All of these developments are just beyond what is available today."

Intelligent Robots

Eventually, robots will be able to respond to a wide variety of sensory cues, to learn by experience, and to acquire skills by self optimization. Such skills would then be transferred to other robots so that learning could be propagated rapidly though out the robot labor force.

Robots continue to acquire increasing intelligence and sensing capability, making them increasingly mobile, dexterous, and adaptable. As a result of the newly available technology to be able to program robots off-line, robots will work longer hours and will not sit idle during programming.

Improved command languages will make robot programming increasingly easy. Eventually, robot programming will consist of simply giving the robot a certain set of tasks or goals and leaving it up to the robot's intelligence to figure out the specifics as to how to best perform the tasks.

Artificial intelligence (AI) is the discipline concerned with developing programs to make robots more intelligent, more human-like. AI is being used in a number of experimental robotic programs.

Lockheed-Georgia, for example, developed a flexible robotic assembly cell that carried out specific operations when given only very general instructions.

"We developed a small prototype system using a robot, a personal computer and a 2-D vision system," explained Mr. Plumley. "We developed a simple AI planning cell which essentially did what an actual manufacturing system would do only on a smaller scale. You would tell the robot cell that you wanted to build a particular assembly. It would then try to find out what that assembly was by running up up to a simple CAD data base.

"It would then research the assembly, not only to find out what it looked like, but what pieces it consisted of, how many holes were required, where they were, and so on. The system then knew it had to drill holes, attach stiffeners or some other operation."

The robot would then use its vision system to locate the part on the parts rack. If the part was the right one, it would, using the vision system again, position the part on a table, locate a clamp, clamp the part, pick up a drill, and simulate drilling.

According to Mr. McMahon, the chief value of AI will be its ability to help systems recover from or correct unforeseen occurrences.

The automated systems, of today, are automated only until something goes wrong, then they need humans to help them recover.

Using AI and other future technologies, tomorrow's robot will not only be a servant but also will be a decision maker. And someday, it will not only be able to adapt to a constantly changing shop floor but be able to learn while on the job.

CAN COPPER BOUNCE BACK AFTER BEING FLOORED?

Although the U.S. companies place themselves in the center of the cost spectrum, the World Bank scenario seems to point toward contraction of capacity in North America and more dependence on South American and African sources.

BY ROBERT J. REGAN

It's no secret that the 1983-84 business recovery passed copper by, trailing in its wake a lengthening string of pundits predicting the demise of the U.S. copper industry, or large parts of it.

It's also no secret that back in the 70s these same pundits were pronouncing the demise of the convertible car and the end of the romance with the automobile. The "rag top" of course, is back with us (for the time being at least) and Detroit's recovery suggests that the romance didn't end, it just went into therapy.

Copper's problems are deeper than the car industry's and, while they can't be cured overnight by whimsical shifts in consumer preference, they aren't necessarily terminal. The industry's self-diagnosis includes a quick fix from higher copper prices and a measure of assistance from government circles to help ride out the time it takes for foreign producers to exhaust their potential for trading cheap copper to European and U.S. consumers for quick-fix foreign exchange resources. Meanwhile, the U.S. companies will keep slugging at the World Bank, the IMF and international lending agencies they hold have prolonged the agony.

Curiously enough, the World Bank recently revised downward its assessment of copper price prospects from 1982 projections, citing "structural changes in demand and supply, namely the worsened demand outlook, the continued competition between producers for market shares and the reassessment of the projected costs of production of the additional capacity required to come onstream during the projection period." The World Bank said copper prices in 1990-95 should be between 71.5¢ and 78¢ a lb (1983 constant dollars), which it said were substantially lower than its own projections in 1982.

Oddly enough, a chart of free world copper consumption for the 1960-84 period shows a trendline any sales manager would be proud of. And a chart of copper inventories here and abroad shows the trendlines (finally) moving in the right direction for the producers. It's the chart of price trends that the privately-owned copper companies would like to see turned to the wall.

As the World Bank sees it, the downtrend in commercial stocks of copper and anticipated modest increase in consumption should nudge the price of copper up to an average of 70¢ a lb in 1985 from 64¢ a lb in 1984. "The market is likely to continue to be plagued with oversupply tendencies through the end of this decade and the copper price is not expected to break out of its present historical low range. In the face of the depressed market conditions experienced since 1981, copper production costs in U.S. dollar terms have been reduced substantially as a result of phasing out of high cost mines, various cost-cutting measures applied at the mines still operating, and currency devaluations by major copper-producing developing countries under debt-servicing pressures, the extent of which has substantially exceeded their domestic inflation rate."

The Bank said the pressure of debt servicing needs in Chile, Peru, Zambia, Zaire and The Phillipines "are not likely to go away soon, so these countries are likely to continue to maintain exchange rate policies that will ensure the competitiveness of their export sectors.

Slower Growth

"In North America, the high cost mines are likely to remain closed and many of them are likely to be abandoned completely." The Bank said the oversupply problem could be mitigated by 1990, followed by a period in which additions to capacity would be tailored to slower-growing consumption trends once the high-cost operations had withered away.

Although the U.S. companies place themselves in the center of the cost spectrum, the World Bank scenario seems to point toward contraction of capacity in North America and more dependence on South American and African sources.

This could be one reason why the Reagan Administration (specifically the government's interagency task force on copper that worked on the copper producers' unsuccessful bid for import protection last year) has agreed to take another look at the situation. Another reason may be that the flat turn-down constrasted sharply with the treatment accorded the steel producers, on whose behalf the Administration has persuaded seven leading steel exporting countries to cut shipments to the U.S. by 30 pct this year.

The U.S. copper companies have cut production to the bone, working staffs and other expenses (one major producer reportedly was preparing to withdraw from the International Copper Research Association) to points where there is little room left. Unless the companies can improve their price realizations and recover significant shares of the copper market in their own backyard, the attrition rate could spread from mines to a company or two knocking on the door of Chapter 11. Canadian gold miner Echo Bay Mines Ltd. had less than minimal interest in the copper properties of Copper Range Co.

when it agreed to purchase Copper Range Co. from Louisiana Land & Exploration Co. last month. It wanted the gold properties and quickly said it would keep the White Pine, Mich. copper operations closed pending examination of alternatives, one of which is sale to employees of the properties, which have been idle for 2½ years.

U.S. imports of refined copper were up another 5 pct in the first 10 months of 1984 but if the November-December volume was anything like October's, the full year total easily topped 600,000 tons for a gain of 12.7 pct on 1983's 532,399 tons.

The jump in October, to 56,733 tons from 27,687 tons the month before and 32,385 tons in October 1983, marked the return of imports from Chile in volume not seen since the U.S. companies filed for protection from imports early in 1984. Chile's shipments to U.S. copper consumers were down 42 pct, or 111,904 tons, in the 10-month period. The slack was taken up by Canadian copper companies, who stepped up sales in the U.S. market by 106.7 pct, or 91,238 tons, in the period without a murmur from the U.S. companies or from Official Washington. Chile's 21,177-ton shipment to the U.S. in October came close on the heels of the September turn-down on the U.S. producers' bid for relief.

Richard de J. Osborne, president of Asarco, Inc., has calculated that the Administration's misreading of market reaction to its no-relief decision was costly to Chilean and other foreign producers as well as to the U.S. copper industry. Noting in a year-end statement that the copper price went down about 5¢ a pound in the two months following the rejection, he said if that level were to persist, it would cost free world copper producers about $660 million on an annual basis, of which Chile's share would be $135 million and the U.S. share $105 million.

Looking at the market situation, Mr. Osborne said the inventory total still is large by historic standards, but well under recent peaks and "the rate of decline indicates that

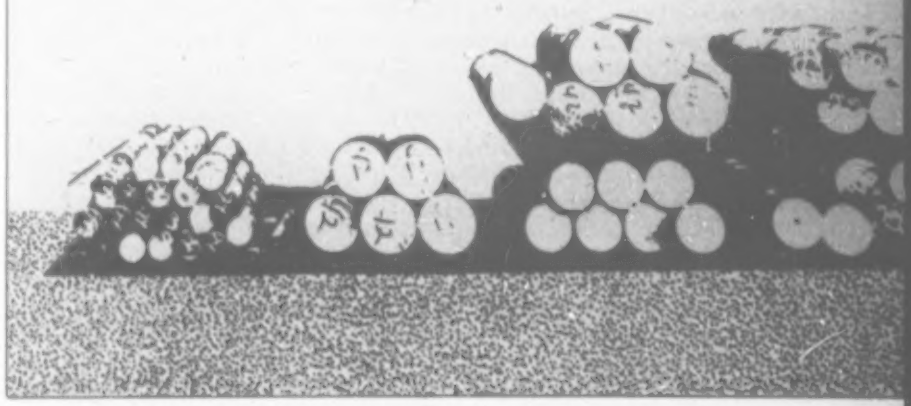
U.S. IMPORTS OF COPPER ON THE RISE AGAIN

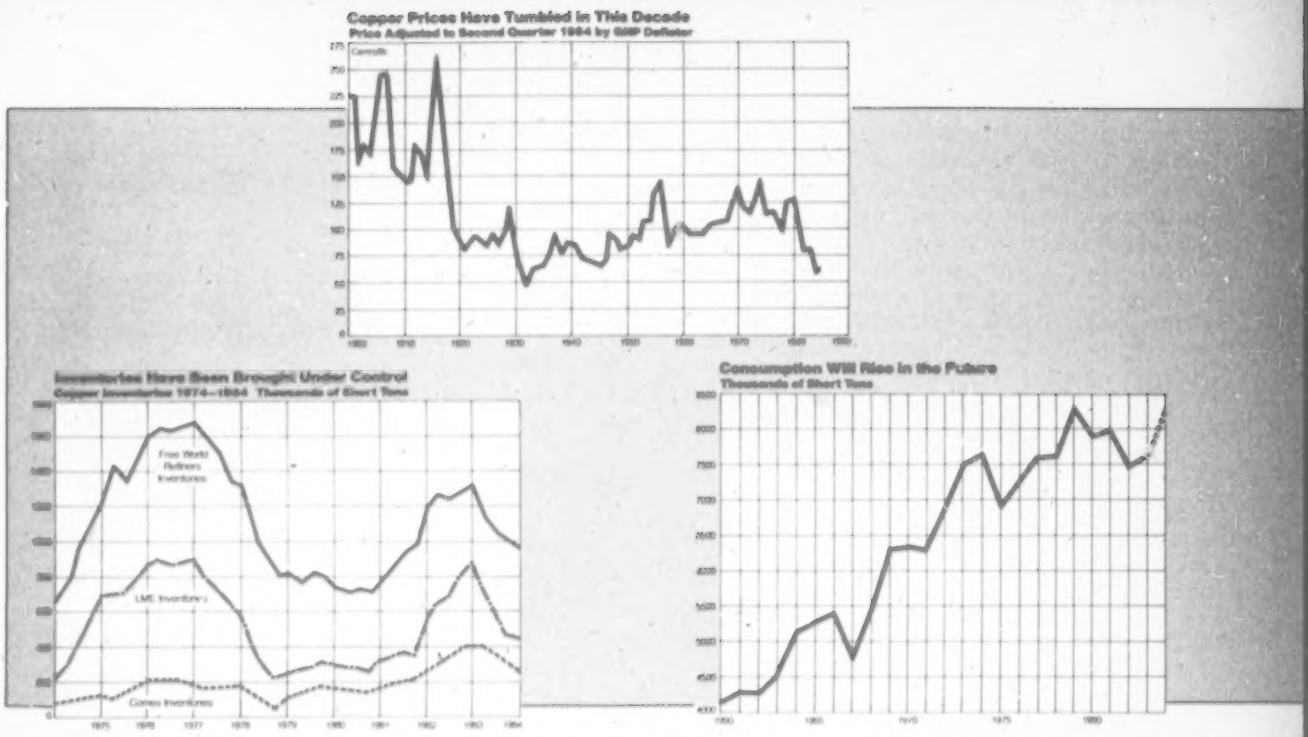
(Short Tons)

	From Chile	From Canada	From All Others
1983			
Jan.	22,711	10,474	4,170
Feb.	22,472	5,466	1,271
Mar.	26,139	16,088	6,348
Apr.	44,404	10,155	24,184
May	30,380	9,470	12,245
June	27,859	9,463	21,962
July	35,743	6,529	13,361
Aug.	22,976	6,117	25,263
Sept.	17,141	6,685	6,340
Oct.	16,671	4,903	10,811
Nov.	19,453	7,141	5,483
Dec.	11,419	7,998	2,924
1984			
Jan.	20,981	7,456	33,409
Feb.	12,832	13,085	7,486
Mar.	17,089	24,537	13,365
Apr.	19,053	31,264	14,713
May	13,850	13,775	17,132
June	12,732	19,254	21,596
July	11,663	20,127	35,677
Aug.	15,716	15,344	5,597
Sept.	9,409	14,420	3,858
Oct.	21,177	17,506	18,050

Source: American Bureau of Metal Statistics

Chile was the prime supplier to U.S. customers throughout 1983 and didn't give way to Canada until early in 1984 when the U.S. producers made their vain bid for import protection. The Reagan Administration formally rejected the U.S. producers' bid in September 1984 and, as the chart shows, by October it was business as usual in the import department. Total imports, of course, were up again in 1984.




Copper Prices Have Tumbled in This Decade
Price Adjusted to Second Quarter 1984 by GNP Deflator
Cents/lb
Inventories Have Been Brought Under Control
Copper Inventories 1974–1984 Thousands of Short Tons
Free World Refiners Inventories
LME Inventories
Comex Inventories
Consumption Will Rise in the Future
Thousands of Short Tons

appropriate economic adjustments are at last taking place." Noting that 1984 may have been a record year for copper consumption, he said this "belies predictions forecasting the demise of the copper business. If, despite substitution of competing materials, downsizing of automobiles and shifts in investments and employment from manufacturing to service industries, the consumption peaks of each cycle are not declining and in fact may be growing, the industry will continue to have the growth which will help to absorb the excess production capacity."

The big if, he said, is supply trends. He noted that much of the capacity now shut down in the U.S. and Canada is unlikely to be reopened under any set of predictable economic assumptions. With no substantial new mine capacity being developed here or abroad, the process of rebalancing supply and demand appears to be occurring. There has been concern, Mr. Osborne said, about the expansion plans of Codelco, Chile's state-owned copper producer and the largest in the free world, because Codelco in the past "has stated a policy of capacity expansion which ignored fundamental market principles of supply and demand."

More recently, Mr. Osborne said, Codelco seems to be having second thoughts and as recently as last October said its long-term plans to boost capacity now hinge on significant improvement in copper prices. If there has been a change in policy in Chile, the Asarco executive said, it marks an important turning point for the copper industry.

Significant Investment

The World Bank's assessment, made earlier in the year, was that many of Chile's planned additions "are likely to be delayed, given the prospect of continued economic difficulties as well as the likelihood of a fairly depressed copper market. Nevertheless, given the availability of extremely attractive and cost-competitive projects, it is possible that significant investment will take place to result in significant increases in (Chile's) capacity—250,000 metric tons by 1990 and an additional 100,000 metric tons by 1995." Chile's goal, the World Bank said, was to boost capacity from 1.25 million metric tons to over 2.2 million metric tons a year by 2000.

The World Bank's own estimates show Chile's mine capacity moving up from 1.243 million metric tons at the end of 1984 to 1.3 million metric tons next year, 1.5 million metric tons by 1990 and 1.6 million metric tons by 1995. Over that same period, U.S. capacity would shrink to 1.3 million metric tons from 1.54 million while Canadian capacity edges up to 900,000 from 870,000 metric tons.

Later this month, the new Congress is due to receive from the Commerce Department a case study of strategic resources which, among other things, asserts that the price of copper has to do better than average 75¢ a lb in 1985-86 or more domestic capacity will have to be surrendered and more copper imported. Industry sources said the study takes a harder line with foreign producers than that generated during the import quota debate last year, Chile in particular.

How much assistance this, together with the earlier decision by the government's interagency task force on copper to take another look at the industry's problems, provides in the upcoming international debate on copper production levels remains to be seen. Of more immediate importance to the U.S. copper producers, is holding out until the cavalry arrives. Copper prices on the hedge markets right up to Christmas week still were ignoring positive fundamentals, like declining inventories, declining interest rates and political problems in Chile, leaving the long-hoped-for recovery dangling just out of reach until a favorable wind pushes it closer. □

PRICE & PRODUCTION DATA

(Effective January 2,1985)

Steel production by districts, thousands of tons

(000 omitted)	Last Week	Two Weeks Ago	Month Ago	Year Ago
Northeast Coast	120	140	178	188
Pittsburgh	115	149	161	204
Youngstown	62	85	60	95
Lake Erie	94	114	115	135
Detroit	133	141	144	125
Chicago	344	369	418	453
Cincinnati	77	66	90	91
St. Louis	48	70	67	58
Southern	131	152	168	162
Western	61	65	62	81
U.S. Production	1,185	1,351	1,463	1,600

Source: American Iron & Steel Institute

Lake Superior Ore Prices

51.50% Fe Natural delivered lower Lake ports. Rail transportation, handling and unloading may be charged to the account of the buyer. Coarse ore 80¢ premium.

Pellets (per iron unit natural ..... gross-ton 80.50-86.9*
Mesabi, regular-unscreened ..... gross-ton $32.53
Mesabi, non-bessemer ..... gross-ton $30.03-31.53**

*80.50¢—Pickands Mather as of 1/27/81.
86.9¢—U.S. Steel as of 3/15/82. Cleveland-Cliffs as of 2/26/82. Oglebay Norton as of 3/25/82, and Hanna Mining as of 2/26/82.
**Effective 8/1/82.

STEEL PRODUCTION, COMPOSITE PRICES

(Effective January 2,1985)

U.S. Steel Production	Last Week	Two Weeks Ago	To Date 1984	To Date 1983
Net tons, in thousands	1,185	1,351	90,859	82,217
Capability Utilization Rate	45.7	52.2	67.5	54.7

Composite Prices (Effective December 28, 1984)	This Week	Week Ago	Month Ago	Year Ago
Finished Steel Base* (¢/lb.—eff. 7/1/84)	27.582	27.582	27.582	26.822
Pig Iron** (Net ton= 2000 lbs.)	$213.00	$213.00	$213.00	$213.00
Scrap No. 1 hvy.*** (Gross ton=2240 lbs.)	$ 80.17	$ 79.50	$ 78.50	$ 89.50
No. 2 bundles	$ 51.50	$ 51.50	$ 51.17	$ 58.17

Scrap Comparison (Gross Ton)

No. 1 steel, Pittsburgh	$ 83.50	$ 81.50	$ 79.50	$ 96.50
No. 1 steel, Philadelphia	76.50	76.50	75.50	86.50
No. 1 steel, Chicago	80.50	80.50	80.50	85.50
No. 1 bundles, Detroit	70.50	61.50	64.50	86.50
Low Phos., Youngstown	72.50	72.50	72.50	88.50
No. 1 mach'y cast., Pgh	66.50	66.50	66.50	79.50
No. 1 mach'y cast., Phila	98.50	98.50	98.50	97.50
No. 1 mach'y cast., Chi	111.50	110.50	110.50	113.50

*Finished Steel Composite. Weighted index of steel bars, shapes, plates, wire, rails, black pipe, hot and cold rolled sheets and strips.
**Pig Iron Composite. Based on average prices for basic and foundry pig iron at representative producing points within the U.S.
***Steel Scrap Composite. Average of No. 1 hvy. melting steel scrap and No. 2 bundles delivered to consumers at Pittsburgh, Philadelphia and Chicago.

NONFERROUS PRICES

(Effective December 28,1984) Prices obtained in trade based on representative tonnages per gross ton delivered to consumer unless otherwise stated.

Primary Metal Prices

(cents per lb.)	current price	last price	date of change
Aluminum (LME)	N.A.	49.35	12/28/84
Copper (C)	63.00-65.00	64.00-65.00	12/20/84
Lead	20.00-23.00	21.00-23.00	12/18/84
Magnesium Ingot	148.00	143.00	5/25/84
Nickel (LME)	N.A.	222.72	12/28/84
Titanium Sponge	555.00-585.00	555.00	4/29/82
Zinc	45.00	45.00-46.00	9/21/84

ALUMINUM: Avg. for last week & previous week. COPPER (C) = cathode. LEAD: common grade. MAGNESIUM: 99.8% p.g. delivered. NICKEL: Avg. for last week & previous week. Canada. ZINC: high grade.

Antimony, American Laredo, Texas	$2.00
Beryllium-aluminum 5% Be, per lb. contained Be	$230.00
Beryllium-copper, per lb. cont. Be	$140.00
Beryllium 97% powder 200	$178.00
Cadmium, ton lots	$1.25-1.55
Calcium, ton lots, crown	$3.58
Chromium, 99.8%	$3.75
Cobalt, 99%, cathode	$12.50
Gold per troy oz.	$308.30
Indium, dollars per troy oz.	$3.10-3.30
Iridium, dollars per troy oz.	$450.00
Magnesium sticks, 10,000 lbs.	$1.97
Mercury, per 76-lb. f.o.b. N.Y.	$315.00-328.00
Molybdenum, lb. tech. moly oxides, 20 lb. MO can	$6.85
Nickel electro (PDCR)	$3.29
Palladium, per troy oz.	$129.00
Platinum, per troy oz.	$292.00
Rhodium, per troy oz.	$815.00
Silver ingots, per troy oz.	$6.36
Vanadium	$6.00
Zirconium sponge	$12.00-17.00

(Per lb. unless otherwise noted)

Straits Tin Price

(U.S. cents per lb. EX-SMELTER, based on daily market in Penang in Malaysian dollars per kilo.)

Dec. 24—547.41 Dec. 27—546.35
Dec. 25—Holiday Dec. 28—545.82
Dec. 26—549.65

Scrap Prices
Brass Mill Scrap

(Cents per lb.; over 20,000 lbs. add 1¢ per lb)

	Solids	Turnings
Copper	58½	49¼
Yellow brass	53½	50
Red brass	55	47¾
Comm. bronze	55⅞	48¼
Mang. bronze	56¼	45½
Free cutting rod ends	51	50

Custom Smelters Scrap

(Cents per lb., carload lots, del. refinery)

No. 1 copper wire	53
No. 2 copper wire	45
Light copper	36

Ingot Makers Scrap

(Cents per lb., carload lots, del. refinery)

No. 1 copper wire	49
No. 2 copper wire	41
Light copper	32
No. 1 composition	45
No. 1 comp. turnings	43
Hvy. yellow brass solids	33
Hvy. yellow brass turnings	31
Radiators	36

Aluminum		
New mixed clips	35	— 36
Old sheet	33	— 34
Old cast	33	— 34
Clean dry borings	33	— 34

Dealers' Scrap

(Dealers' buying price f.o.b. New York in cents per pound)

Aluminum		
Segregated clippings	31	— 32
Mixed U.C. clips	28	— 30
Old sheets and cast	24	— 26
Borings and turnings	22	— 23
Duraluminum clippings	25	— 26

Copper and Brass		
No. 1 copper wire	44	— 46
No. 2 copper wire	37	— 38
Light copper	31	— 33
Radiators	32	— 33
No. 1 composition	40	— 41
No. 1 composition turnings	37	— 38
Cocks and faucets	29	— 31
Clean heavy yellow brass	28	— 30
Brass Pipe	28	— 29
New soft brass clippings	41	— 42

Lead		
Heavy soft lead	9	— 10
Whole batteries	1	— 3
Type metal	16	— 17
Electrotype	13	— 14

Nickel		
Nickel solids	115	—120
Nickel rod ends	115	—120
Nickel sheets, clips	115	—120
Nickel turnings	40	— 45

Zinc		
New zinc clippings	18	— 19
Old diecast zinc	14	— 15

EFFECTIVE DECEMBER 28,1984

(Effective December 28,1984) Prices published in trade based on representative tonnages per gross ton delivered to consumer unless otherwise stated. Prices are the opinions of Iron Age editors and correspondents, based on contacts with dealers, brokers, generators and users in the industry, on the effective date listed above.

Ferrous Scrap Prices

Pittsburgh

No. 1 hvy. melting	$ 63.00 to	$ 64.50
No. 2 hvy. melting	73.00 to	74.00
No. 1 dealer bundles	90.00 to	91.00
No. 1 factory bundles (auto)	92.00 to	93.00
No. 2 bundles	50.00 to	51.00
No. 1 bushelling	94.00 to	95.00
Machine shop turnings	10.00 to	11.00
Shoveling turnings	51.00 to	52.00
Cast iron borings	49.00 to	50.00
Low phos. punchings plate	101.00 to	102.00
Heavy turnings	71.00 to	72.00
No. 1 RR hvy. melting	93.00 to	94.00
Rails, 2 ft and under	107.00 to	108.00
Scrap rails, random lgth	91.50 to	92.00
RR specialties	97.00 to	98.00
No. 1 machinery cast	66.00 to	67.00
Cupola cast	59.00 to	60.00
Heavy breakable cast	30.00 to	31.00
Stainless		
18-8 bundles and solids	570.00 to	580.00
18-8 turnings	470.00 to	480.00

Chicago

No. 1 hvy. melting	$ 80.00 to	$ 81.00
No. 2 hvy. melting	75.00 to	76.00
No. 1 dealer bundles	92.00 to	93.00
No. 1 factory bundles (auto)	93.00 to	94.00
No. 2 dealer bundles	57.00 to	58.00
No. 1 bushelling	89.00 to	90.00
Shredder scrap	91.00 to	92.00
Machine shop turnings	43.00 to	44.00
Mixed borings and turnings	44.00 to	45.00
Shoveling turnings	48.00 to	49.00
Cast iron borings	48.00 to	49.00
Low phos. forge crop	116.00 to	117.00
Low phos. punchings plate 1/4 in. and heavier	127.00 to	128.00
Low phos. 2 ft and under	122.00 to	123.00
No. 1 RR hvy. melting	86.00 to	87.00
Scrap rails random lgth	88.00 to	89.00
Reroller rails	99.00 to	100.00
Rails, 2 ft and under	113.00 to	114.00
RR couplers and knuckles	90.00 to	91.00
RR car axles	123.00 to	124.00
No. 1 machinery cast	111.00 to	112.00
Cupola cast	99.00 to	100.00
Stove plate	97.00 to	98.00
Steel car wheels	100.00 to	101.00
Stainless		
18-8 bundles and solids	510.00 to	520.00
18-8 turnings	430.00 to	440.00
430 bundles and solids	135.00 to	140.00
430 turnings	105.00 to	110.00

Philadelphia

No. 1 hvy. melting	$ 73.00 to	$ 75.00
No. 2 hvy. melting	67.00 to	70.00
No. 1 dealer bundles	87.00 to	90.00
No. 2 dealer bundles	45.00 to	43.00
No. 1 bushelling	87.00 to	90.00
Shredder scrap	96.00 to	99.00
Machine shop turnings	29.00 to	32.00
Mixed borings and turnings	29.00 to	32.00
Shoveling turnings	38.00 to	41.00
Low phos. 5 ft and under	84.00 to	87.00
Low phos. 2 ft punchings	110.00 to	113.00
Electric furnace bundles	98.00 to	101.00
RR specialties	87.00 to	90.00
Rails, 2 ft and under	112.00 to	115.00
Cupola cast	76.00 to	79.00
Heavy breakable cast	57.00 to	60.00
No. 1 machinery cast	97.00 to	100.00

Detroit

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 53.00 to	$ 54.00
No. 2 hvy. melting	52.00 to	53.00
No. 1 dealer bundles	70.00 to	71.00
No. 2 bundles	33.00 to	34.00
No. 1 bushelling	69.00 to	70.00
Drop forge flashings	42.00 to	43.00
Machine shop turnings	44.00 to	45.00
Mixed borings and turnings	21.00 to	22.00
Shoveling turnings	45.00 to	46.00
Cast iron borings	31.00 to	32.00
Heavy breakable cast	40.00 to	41.00
Mixed cupola cast	56.00 to	57.00
Automobile cast	80.00 to	81.00
Stainless		
18-8 bundles and solids	445.00 to	455.00
18-8 turnings	350.00 to	360.00
430 bundles and solids	105.00 to	115.00

Youngstown

No. 1 hvy. melting	$ 59.00 to	$ 62.00
No. 2 hvy. melting	42.00 to	45.00
No. 1 dealer bundles	71.00 to	72.00
No. 2 dealer bundles	35.00 to	38.00
Machine shop turnings	11.00 to	14.00
Shoveling turnings	16.00 to	19.00
Low phos. plate	71.00 to	74.00
Electric furnace bundles	69.00 to	72.00
Galvanized bundles	59.00 to	62.00

Cleveland

No. 1 hvy. melting	$ 50.00 to	$ 53.00
No. 2 hvy. melting	34.00 to	37.00
No. 1 dealer bundles	62.00 to	65.00
No. 1 factory bundles	71.00 to	74.00
No. 2 bundles	19.00 to	22.00
No. 1 bushelling	64.00 to	67.00
Machine shop turnings	6.00 to	9.00
Mixed borings and turnings	6.00 to	9.00
Shoveling turnings	7.00 to	10.00
Cast iron borings	10.00 to	13.00
Cut structural & plates 2 ft and under	100.00 to	103.00
Low phos. punchings plate	100.00 to	103.00
Drop forge flashings	35.00 to	38.00
Foundry steel, 2 ft & under	57.00 to	60.00
No. 1 RR hvy. melting	73.00 to	76.00
Rails, 2 ft and under	105.00 to	108.00
Rails, 18 in. and under	106.00 to	109.00
Steel axle turnings	58.00 to	59.00
Railroad cast	89.00 to	91.00
No. 1 machinery cast	99.00 to	101.00
Cupola cast	55.00 to	58.00
Stove plate	41.00 to	44.00
Stainless		
18-8 bundles	376.00 to	385.00
18-8 turnings	325.00 to	335.00
430 bundles	80.00 to	85.00

Buffalo

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 62.00 to	$ 63.00
No. 2 hvy. melting	51.00 to	52.00
No. 1 bushelling	72.00 to	73.00
No. 1 dealer bundles	71.00 to	72.00
No. 2 bundles	36.00 to	37.00
Machine shop turnings	11.00 to	12.00
Mixed boring and turnings	12.00 to	13.00
Shoveling turnings	15.00 to	16.00
Cast iron borings	20.00 to	21.00
Low phos. plate	92.00 to	93.00
Structural and plate 2 ft and under	95.00 to	96.00
Rails, 2 ft and under	95.00 to	96.00
Scrap rails, random lgth	72.00 to	73.00
No. 1 machinery cast	78.00 to	79.00
No. 1 cupola cast	58.00 to	59.00

St. Louis

No. 1 hvy. melting	$ 61.00 to	$ 62.00
No. 2 hvy. melting	50.00 to	51.00
Foundry steel, 2 ft	61.00 to	62.00
No. 1 dealer bundles	61.00 to	62.00
No. 2 bundles	45.00 to	46.00
Machine shop turnings	17.00 to	18.00
Shoveling turnings	23.00 to	24.00
Cast iron borings	27.00 to	28.00
No. 1 RR hvy. melting	61.00 to	62.00
Rails, random length	65.00 to	66.00
Rails, 18 in. and under	81.00 to	82.00
RR specialties	80.00 to	81.00
Cupola cast	74.00 to	75.00
Heavy breakable cast	52.00 to	53.00
Stove plate	89.00 to	90.00
Steel car wheels	94.00 to	95.00
Rerolling rails	78.00 to	79.00
Unstripped motor blocks	61.00 to	62.00

Birmingham

No. 1 hvy. melting	$ 68.00 to	$ 69.00
No. 2 hvy. melting	63.00 to	64.00
No. 1 dealer bundles	69.00 to	70.00
No. 2 bundles	45.00 to	46.00
No. 1 bushelling	69.00 to	70.00
Shredder scrap	94.00 to	95.00
Machine shop turnings	23.00 to	24.00
Shoveling turnings	38.00 to	39.00
Cast iron borings	38.00 to	39.00
Electric furnace bundles	67.00 to	68.00
Elec. furnace, 3 ft & under	68.00 to	69.00
Structural and plate, 2 ft	97.00 to	98.00
Structural and plate, 4 ft	89.00 to	90.00
No. 1 RR hvy. melting	89.00 to	90.00
Scrap rails, random lgth	85.00 to	86.00
Rails, 2 ft and under	103.00 to	104.00
Angles and splice bars	89.00 to	90.00
No. 1 cupola cast	86.00 to	87.00
Unstripped motor blocks	67.00 to	68.00

Cincinnati

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 49.00 to	$ 50.00
No. 2 hvy. melting	48.00 to	50.00
No. 1 dealer bundles	60.00 to	61.00
No. 2 bundles	24.00 to	25.00
Machine shop turnings	4.00 to	5.00
Shoveling turnings	6.00 to	7.00
Cast iron borings	17.00 to	18.00
Low phos. 18 in. and under	82.00 to	83.00
Rails, random length	64.00 to	65.00
Rails, 2 ft and under	77.00 to	78.00
No. 1 cupola cast	54.00 to	55.00
Heavy breakable cast	25.00 to	26.00
Drop broken cast	74.00 to	75.00

New York

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 47.00 to	$ 48.00
No. 2 hvy. melting	38.00 to	39.00
No. 2 dealer bundles	23.00 to	27.00
Mixed borings and turnings	11.00 to	13.00
Machine shop turnings	6.00 to	7.00
Shoveling turnings	14.00 to	15.00
Clean cast, chem. borings	35.00 to	36.00
No. 1 machinery cast	89.00 to	90.00
Mixed yard cast	50.00 to	51.00
Heavy breakable cast	10.00 to	12.00
Stainless		
18-8 prepared solids	490.00 to	510.00
18-8 turnings	390.00 to	410.00
430 prepared solids	90.00 to	110.00
410 solids	80.00 to	90.00

Boston

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 58.00 to	$ 60.00
No. 2 hvy. melting	48.00 to	50.00
No. 1 dealer bundles	58.00 to	60.00
No. 2 bundles	35.00 to	37.00
No. 1 bushelling	65.00 to	67.00
Shredder scrap	65.00 to	67.00
Machine shop turnings	10.00 to	12.00
Shoveling turnings	18.00 to	20.00
No. 1 machinery cast	81.00 to	86.00
Mixed cupola cast	48.00 to	50.00
Heavy breakable cast	8.00 to	10.00

San Francisco

No. 1 hvy. melting	$ 42.00 to	$ 44.00
No. 2 hvy. melting	36.00 to	38.00
No. 1 dealer bundles	33.00 to	35.00
No. 2 dealer bundles	18.00 to	20.00
Machine shop turnings	6.00 to	8.00
Cast iron borings	6.00 to	8.00
No. 1 cupola cast	81.00 to	83.00

Los Angeles

No. 1 hvy. melting	$ 45.00 to	$ 47.00
No. 2 hvy. melting	38.00 to	40.00
No. 1 dealer bundles	36.00 to	38.00
No. 2 dealer bundles	18.00 to	20.00
Machine shop turnings	12.00 to	14.00
Shoveling turnings	8.00 to	10.00
Cast iron borings	6.00 to	8.00
Elec. furnace, 1 ft and under (foundry)	74.00 to	76.00
No. 1 cupola cast	75.00 to	77.00

Seattle

No. 1 hvy. melting	58.00 to	65.00
No. 2 hvy. melting	57.00 to	59.00
No. 2 bundles	40.00 to	42.00
No. 1 cupola cast	92.00 to	93.00
Mixed yard cast	82.00 to	84.00

Hamilton, Ont.

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 87.00
No. 2 hvy. melting, cut 2 ft and under	81.00
No. 1 dealer bundles	88.00
No. 2 bundles	60.00
Mixed steel scrap	57.00
Bush. new fact. prep'd	89.00
Bush. new fact. unprp'd	79.00
Machine shop turnings	31.00
Short steel turnings	33.00
Mixed borings and turnings	25.00
Cast scrap	79.00

Houston

Brokers buying prices per gross ton on cars

No. 1 hvy. melting	$ 69.00 to	$ 70.00
No. 2 hvy. melting	56.00 to	57.00
No. 2 bundles	42.00 to	43.00
Machine shop turnings	12.00 to	13.00
Crushed turnings	29.00 to	31.00
Shredder scrap	73.00 to	74.00
Cut structural plate, 2 ft and under	99.00 to	101.00
Cut structural plate, 5 ft and under	83.00 to	85.00
Unstripped motor blocks	60.00 to	61.00
Cupola cast	77.00 to	78.00

FOOD AND ENERGY PUSH PRICES HIGHER

Producer prices rose in November for the first time in three months.

The surge—0.5 pct—was led by rising food and energy prices, according to the Bureau of Labor Statistics (BLS). It also marked a return to the rate that prevailed in early 1984, BLS said. Thus the 11-month run of statistics indicates inflation at the producer level running at an annual rate of 1.9 pct, about three times the rate of 1983.

Capital equipment prices increased slightly—0.2 pct—in the wake of a relatively large drop—0.6 pct—a month earlier. Unadjusted prices for autos rose 0.2 pct.

Construction machinery prices moved up after posting no change in October. And prices of pumps, compressors, and industrial process furnaces and ovens increased much more than in the previous month.

The index for intermediate materials supplies and components rose 0.3 pct from October to November on a seasonally adjusted basis. Those figures had declined slightly from June through September and then edged up in October. After falling for several months, the index for primary nonferrous metals rose.

There was no increase in November compared with October for valves and fittings while miscellaneous metal products went up 1.2 pct.

For machine tools, prices for metalcutting types rose 1.1 pct, while there were no changes in prices for metalforming tools.

Unadjusted prices for mechanical power transmission equipment fell 0.1 pct. Railroad equipment prices also declined after two consecutive months of stability, while electric motors, which were up 0.8 pct in October, dropped 0.4 pct in November.

Overall, of the 22 categories shown, 11 rose, seven were down and four were unchanged compared with October, the government said.

Latest Month Covered: November 1984

Products	Index Reading For Month (1967 = 100)	Pct Change From Previous Month	Pct Change From Year-Ago Month
Metal Cutting Machine Tools	393.9	+ 1.1	+ 4.3
Metal Forming Machine Tools	426.8	0	+ 1.9
Agricultural Machinery & Equip.	337.2	— 0.2	+ 2.6
Construction Machinery & Equip.	360.1	+ 0.3	+ 1.8
Industrial Process Furnace & Ovens	381.8	+ 1.4	+ 3.4
Industrial Material Handling Equip.	291.4	+ 0.1	+ 1.9
Pumps, Compressors & Allied Equip.	354.3	+ 1.1	+ 2.5
Fluid Power Equip. (Dec. 1970 = 100)	261.4	0	+ 2.8
Mechanical Power Transmission Equip.	330.3	— 0.1	+ 3.6
Automobiles	223.0	+ 0.2	+ 0.5
Motor Trucks—Light	290.3	+ 0.2	+ 3.7
Motor Trucks—Heavy	331.1	0	+ 4.2
Railroad Equipment	358.8	— 1.6	+ 2.9
Fabricated Metal Structural Products	313.0	— 0.3	+ 2.5
Electric Motors	341.7	— 0.4	+ 1.7
Valves & Fittings (Dec. 1982 = 100)	102.8	0	+ 2.8
Ball & Roller Bearings	345.5	+ 0.1	+ 3.4
Cutting Tools & Accessories	283.0	+ 0.5	+ 2.8
Heating Equipment	256.3	— 0.7	+ 4.4
Plumbing Fixtures & Brass Fittings	301.4	+ 0.3	+ 2.5
Metal Containers	357.5	— 0.1	+ 5.7
Miscellaneous Metal Products	301.3	+ 1.2	+ 4.1

Data based on U.S. Labor Dept.'s Producer Price Index